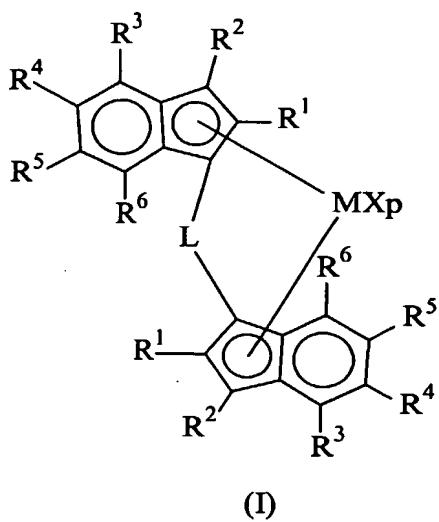


## CLAIMS

1. A process for preparing 1-butene polymers optionally containing up to 30% by mol of derived units of ethylene, propylene or an alpha olefin of formula  $\text{CH}_2=\text{CHZ}$ , wherein Z is a  $\text{C}_3\text{-C}_{10}$  alkyl group, comprising polymerizing 1-butene and optionally ethylene, propylene or said alpha olefin, in the presence of a catalyst system obtainable by contacting:

a) at least a metallocene compound of formula (I):



wherein:

M is an atom of a transition metal selected from those belonging to group 3, 4, 5, 6 or to the lanthanide or actinide groups in the Periodic Table of the Elements;

p is an integer from 0 to 3, being equal to the formal oxidation state of the metal M minus 2;

X, equal to or different from each other, are hydrogen atoms, halogen atoms, or R, OR,  $\text{OSO}_2\text{CF}_3$ , OCOR, SR,  $\text{NR}_2$  or  $\text{PR}_2$  groups, wherein R is a linear or branched, saturated or unsaturated  $\text{C}_1\text{-C}_{20}$  alkyl,  $\text{C}_3\text{-C}_{20}$  cycloalkyl,  $\text{C}_6\text{-C}_{20}$  aryl,  $\text{C}_7\text{-C}_{20}$  alkylaryl or  $\text{C}_7\text{-C}_{20}$  arylalkyl radical, optionally containing heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements; or two X can optionally form a substituted or unsubstituted butadienyl radical or a OR'O group wherein R' is a divalent radical selected from  $\text{C}_1\text{-C}_{20}$  alkylidene,  $\text{C}_6\text{-C}_{40}$  arylidene,  $\text{C}_7\text{-C}_{40}$  alkylarylidene and  $\text{C}_7\text{-C}_{40}$  arylalkylidene radicals;

$\text{R}'$ , equal to or different from each other, are linear or branched, saturated or unsaturated  $\text{C}_1\text{-C}_{20}$ -alkyl,  $\text{C}_3\text{-C}_{20}$ -cycloalkyl,  $\text{C}_6\text{-C}_{20}$ -aryl,  $\text{C}_7\text{-C}_{20}$ -alkylaryl or

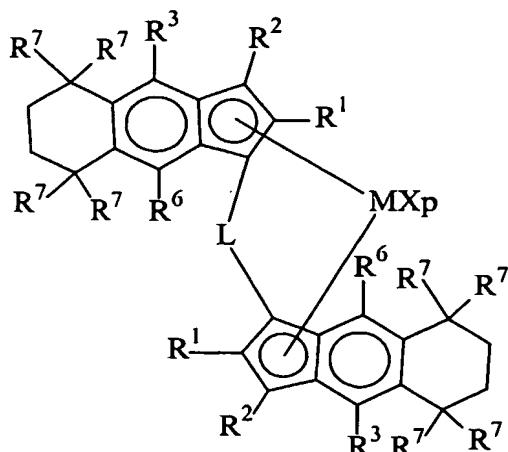
$C_7$ - $C_{20}$ -arylalkyl radicals, optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements;

$R^2$ ,  $R^3$  and  $R^6$ , equal to or different from each other, are hydrogen atoms or linear or branched, saturated or unsaturated  $C_1$ - $C_{20}$ -alkyl,  $C_3$ - $C_{20}$ -cycloalkyl,  $C_6$ - $C_{20}$ -aryl,  $C_7$ - $C_{20}$ -alkylaryl or  $C_7$ - $C_{20}$ -arylalkyl radicals, optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements;

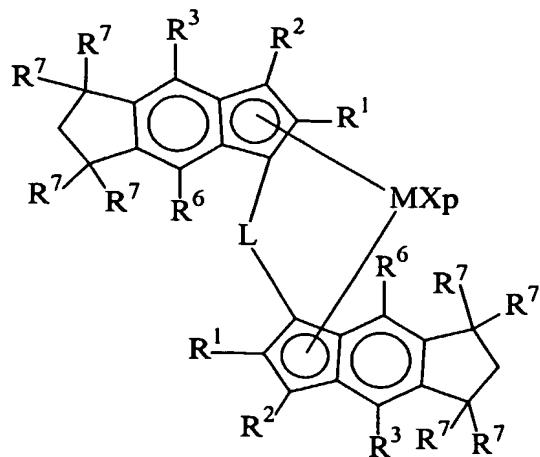
$R^4$  and  $R^5$ , form together a condensed saturated or unsaturated  $C_3$ - $C_7$  membered ring optionally containing heteroatoms belonging to groups 13-16 of the Periodic Table of the Elements; every atom forming said ring being substituted with  $R^7$  radicals wherein  $R^7$ , equal to or different from each other, are hydrogen atoms or linear or branched, saturated or unsaturated  $C_1$ - $C_{20}$ -alkyl,  $C_3$ - $C_{20}$ -cycloalkyl,  $C_6$ - $C_{20}$ -aryl,  $C_7$ - $C_{20}$ -alkylaryl or  $C_7$ - $C_{20}$ -arylalkyl radicals, optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements;

$L$  is a divalent bridging group selected from  $C_1$ - $C_{20}$  alkylidene,  $C_3$ - $C_{20}$  cycloalkylidene,  $C_6$ - $C_{20}$  arylidene,  $C_7$ - $C_{20}$  alkylarylidene, or a  $C_7$ - $C_{20}$  arylalkylidene radical optionally containing heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements, or a silylidene radical containing up to 5 silicon atoms; and

- b) an alumoxane or a compound able to form an alkylmetallocene cation.
- 2. The process according to claim 1 wherein the catalyst system further comprises an organo aluminum compound.
- 3. The process according to claim 1 or 2, wherein in the compound of formula (I)  $M$  is titanium, zirconium or hafnium;  $X$  is a hydrogen atom, a halogen atom or a  $R$  group wherein  $R$  has the same meaning as in claim 1 and  $L$  is  $Si(R^8)_2$ , wherein  $R^8$  is a linear or branched, saturated or unsaturated  $C_1$ - $C_{20}$ -alkyl,  $C_3$ - $C_{20}$ -cycloalkyl,  $C_6$ - $C_{20}$ -aryl,  $C_7$ - $C_{20}$ -alkylaryl or  $C_7$ - $C_{20}$ -arylalkyl radical.
- 4. The process according to anyone of claims 1 to 3 wherein  $R^1$  is a  $C_1$ - $C_{20}$ -alkyl radical;  $R^2$ ,  $R^3$  and  $R^6$  are hydrogen atoms and  $R^7$  is a hydrogen atom or a linear or branched, saturated or unsaturated  $C_1$ - $C_{20}$ -alkyl radical.
- 5. The process according to anyone of claims 1 to 4 wherein the compound of formula (I) has formula (IIa) or (IIb):



(IIa)

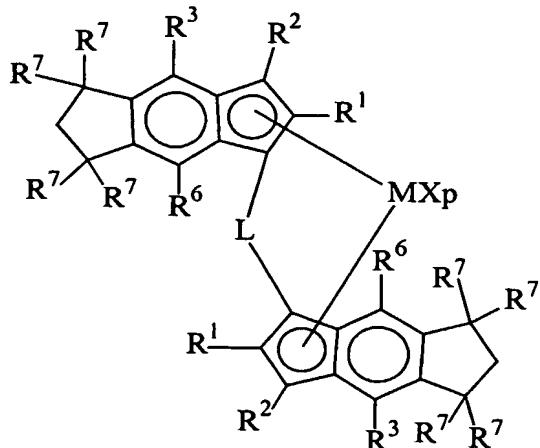


(IIb)

wherein:

M, X, p, L, R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>6</sup> and R<sup>7</sup> have the same meaning as in claim 1.

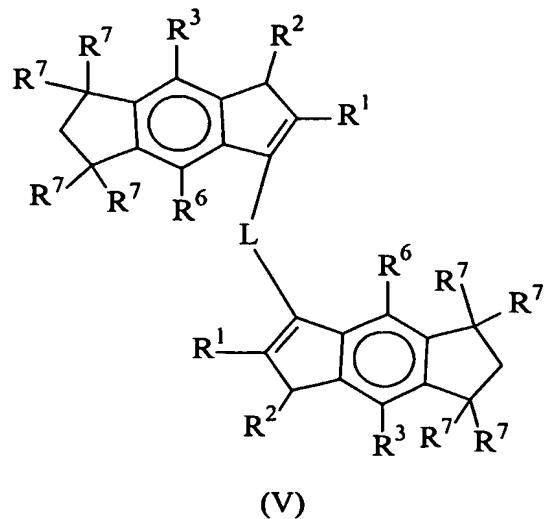
6. The process according to anyone of claims 1 to 5 wherein 1-butene is homopolymerized.
7. A metallocene compound of formula (IIb):



(IIb)

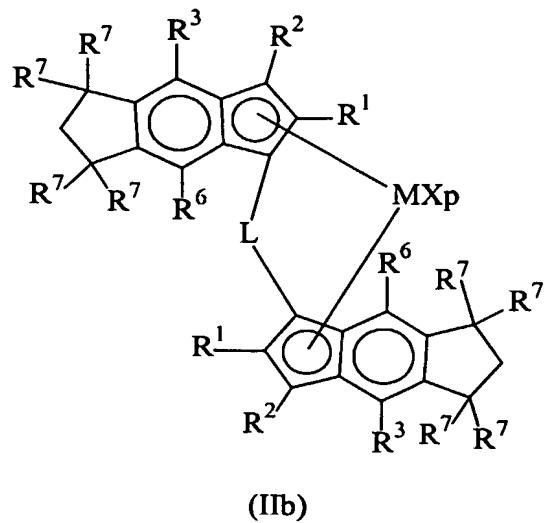
wherein M, p, L, R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>6</sup>, R<sup>7</sup> and X have the same meaning as in claim 1.

8. A ligand of formula (V) or its corresponding double bond isomer:



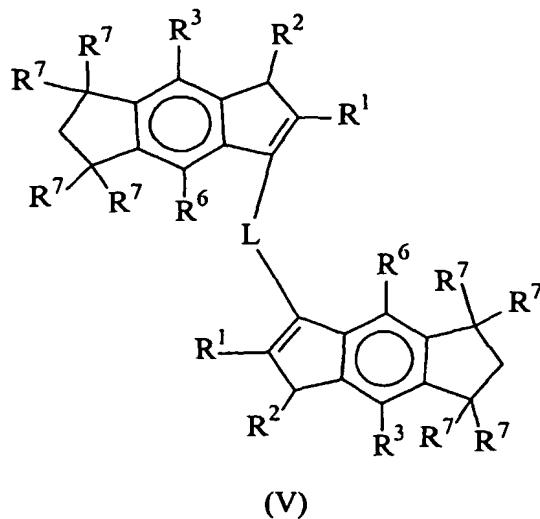
wherein L, R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>6</sup>, and R<sup>7</sup> have the same meaning as in claim 1.

9. A process for preparing the metallocene compound of formula (IIb):



wherein M, p, L, R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>6</sup>, R<sup>7</sup> and X have the same meaning as in claim 1 comprising the following steps:

a) contacting a ligand of formula (V)

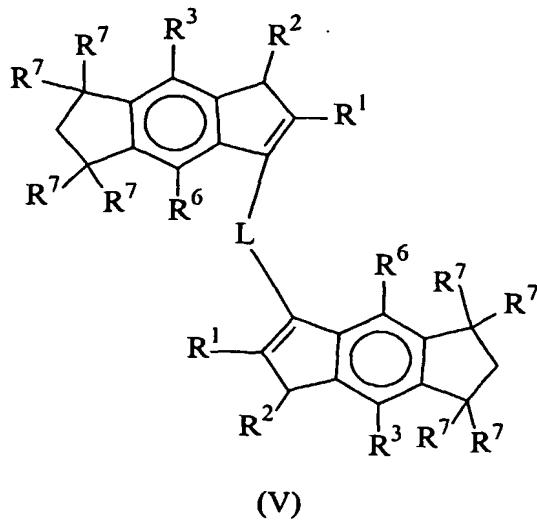


or its double bond isomer

wherein  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^6$ ,  $R^7$  and  $L$  have the same meaning as in claim 1 with a base of formula  $T_jB$  or  $TMgT^1$ , or sodium or potassium hydride, or metallic sodium or potassium; wherein  $B$  is an alkaline or alkali-earth metal and  $j$  is 1 or 2,  $j$  being equal to 1 when  $B$  is an alkaline metal, and  $j$  being equal to 2 when  $B$  is an alkali-earth metal;  $T$  is selected from the group consisting of linear or branched, saturated or unsaturated  $C_1-C_{20}$  alkyl,  $C_3-C_{20}$  cycloalkyl,  $C_6-C_{20}$  aryl,  $C_7-C_{20}$  alkylaryl or  $C_7-C_{20}$  arylalkyl groups, optionally containing one or more Si or Ge atoms;  $T^1$  is a halogen atom or a group  $OR''$  wherein  $R''$  is a linear or branched, saturated or unsaturated  $C_1-C_{20}$ -alkyl,  $C_3-C_{20}$ -cycloalkyl,  $C_6-C_{20}$ -aryl,  $C_7-C_{20}$ -alkylaryl or  $C_7-C_{20}$ -arylalkyl radicals, optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements; wherein the molar ratio between said base and the ligand of the formula (V) and is at least 2:1; and

- b) contacting the product obtained in step a) with a compound of formula  $MX_4$  wherein  $M$  and  $X$  have the same meaning as in claim 1.

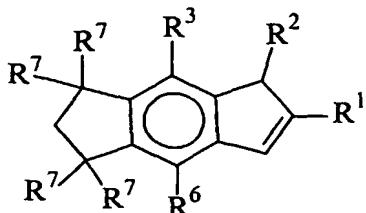
10. A process for preparing the ligand of formula (V)



or its double bond isomer

wherein  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^6$ ,  $R^7$  and  $L$  have the same meaning as in claim 1, comprising the following steps:

a) contacting a compound of formula (VI):



(VI)

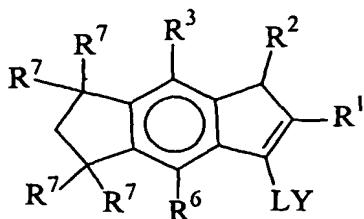
or its double bonds isomer

wherein:  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^6$ , and  $R^7$  have the same meaning as in claim 1;

with a base of formula  $T_jB$  or  $TMgT^1$ , or sodium or potassium hydride, or metallic sodium or potassium; wherein B is an alkaline or alkali-earth metal and j is 1 or 2, j being equal to 1 when B is an alkaline metal, and j being equal to 2 when B is an alkali-earth metal; T is selected from the group consisting of linear or branched, saturated or unsaturated  $C_1-C_{20}$  alkyl,  $C_3-C_{20}$  cycloalkyl,  $C_6-C_{20}$  aryl,  $C_7-C_{20}$  alkylaryl or  $C_7-C_{20}$  arylalkyl groups, optionally containing one or more Si or Ge atoms;  $T^1$  is a halogen atom or a group  $OR''$  wherein  $R''$  is a linear or branched, saturated or unsaturated  $C_1-C_{20}$ -alkyl,  $C_3-C_{20}$ -cycloalkyl,  $C_6-C_{20}$ -aryl,  $C_7-C_{20}$ -alkylaryl or  $C_7-C_{20}$ -arylalkyl radicals, optionally containing one or more heteroatoms belonging to groups 13-17 of the

Periodic Table of the Elements; wherein the molar ratio of said base and the compound of the formula (VI) is at least 1:1;

b) contacting the obtained anionic compounds obtained in step a) with a compound of formula (VII):



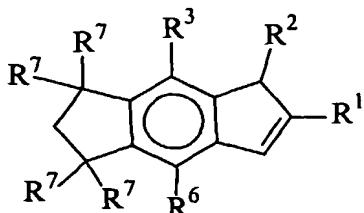
(VII)

or its double bonds isomer

wherein R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>6</sup>, R<sup>7</sup> and L have the same the same meaning as in claim 1 and Y is a halogen radical selected from the group consisting of chloride, bromide and iodide.

11. A process for preparing the ligand of formula (V) when the substituents R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>6</sup> and R<sup>7</sup> are the same in both the indenyl moieties comprising the following steps:

a) contacting a compound of formula (VI):



(VI)

or its double bonds isomer

wherein: R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>6</sup> and R<sup>7</sup> have the same the same meaning as in claim 1; with a base of formula T<sub>j</sub>B or TMgT<sup>1</sup>, or sodium or potassium hydride, or metallic sodium or potassium; wherein B is an alkaline or alkali-earth metal and j is 1 or 2, j being equal to 1 when B is an alkaline metal, and j being equal to 2 when B is an alkali-earth metal; T is selected from the group consisting of linear or branched, saturated or unsaturated C<sub>1</sub>-C<sub>20</sub> alkyl, C<sub>3</sub>-C<sub>20</sub> cycloalkyl, C<sub>6</sub>-C<sub>20</sub> aryl, C<sub>7</sub>-C<sub>20</sub> alkylaryl or C<sub>7</sub>-C<sub>20</sub> arylalkyl groups, optionally containing one or more Si or Ge atoms; T<sup>1</sup> is a halogen atom or a group OR" wherein R" is a linear or branched, saturated or unsaturated C<sub>1</sub>-C<sub>20</sub>-alkyl, C<sub>3</sub>-C<sub>20</sub>-cycloalkyl,

$C_6$ - $C_{20}$ -aryl,  $C_7$ - $C_{20}$ -alkylaryl or  $C_7$ - $C_{20}$ -arylalkyl radicals, optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements; wherein the molar ratio between said base and the compound of the formula (VI) is at least 1:1;

- b) reacting the product obtained in step a) with a compound of formula YLY, wherein L and Y have the same the same meaning as in claim 9 wherein the molar ratio between the compound obtained in step a) and the compound of formula YLY is at least 2:1